No. 847,614. PATENTED MAR. 19, 1907.

S. B. SHELDON.

COKE FURNACE.

APPLICATION FILED APR. 21, 1906.

6 SHEETS—SHEET 1.

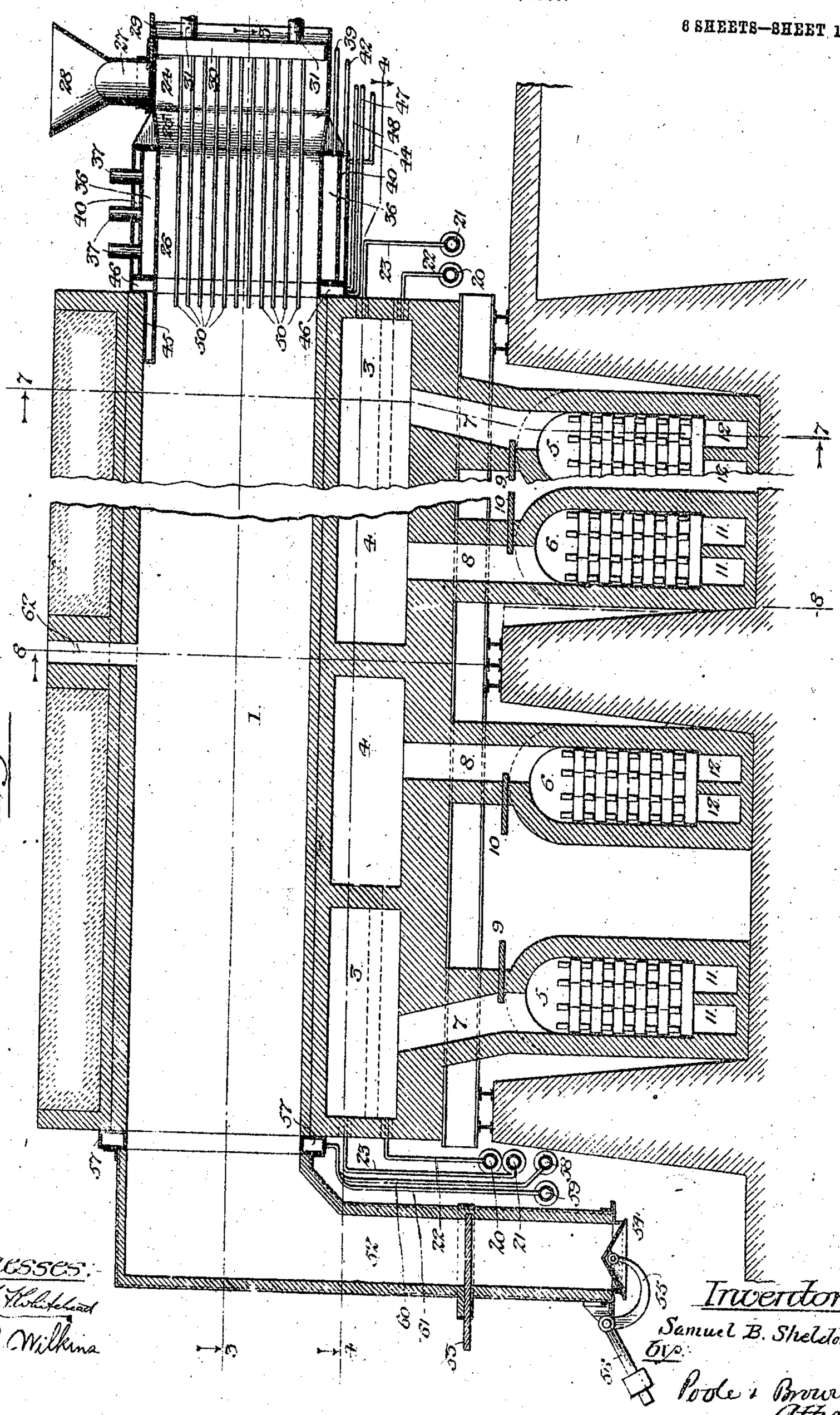

FIG. 1.

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6 SHEETS—SHEET 2.

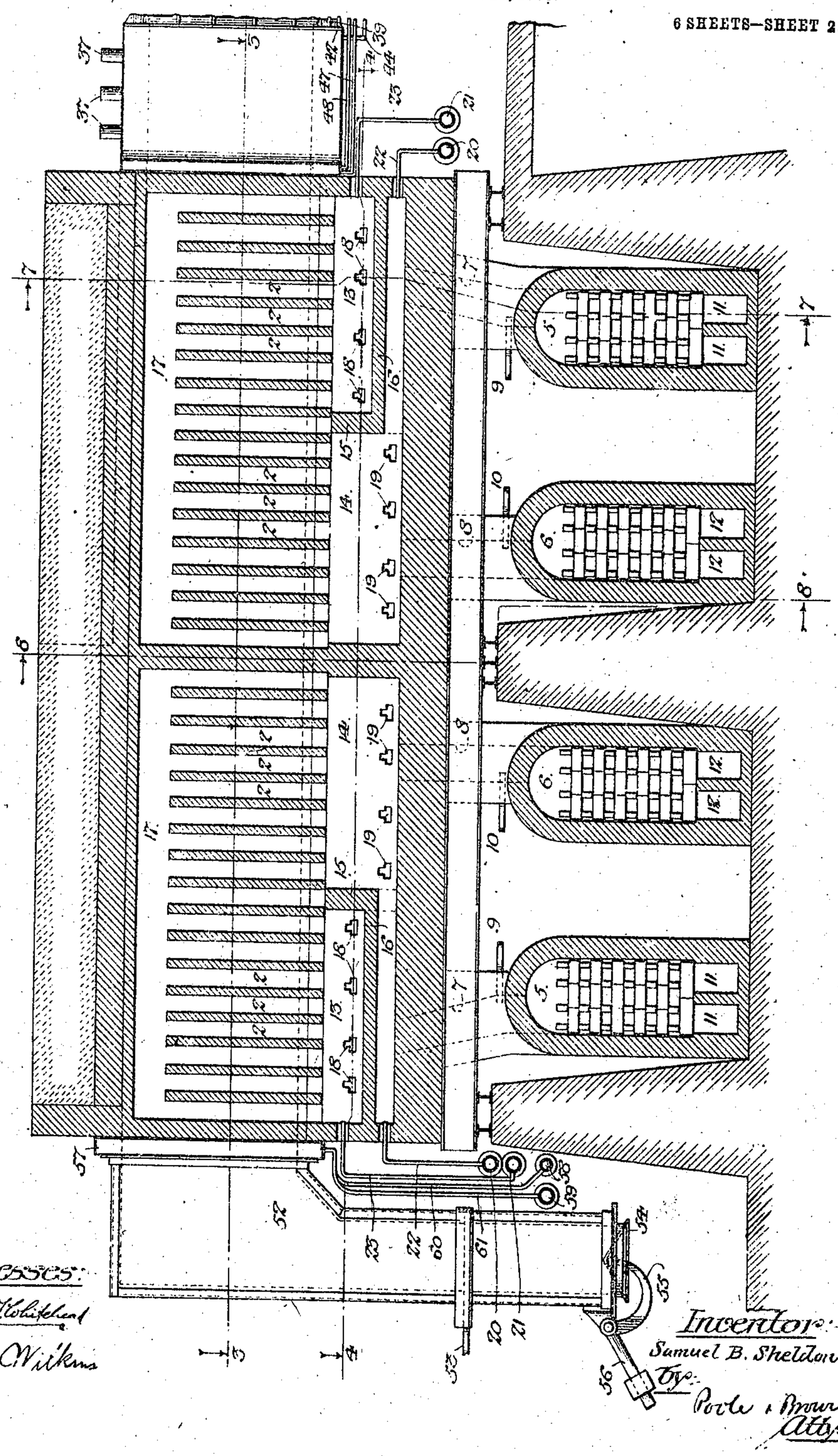

Fig. 2.

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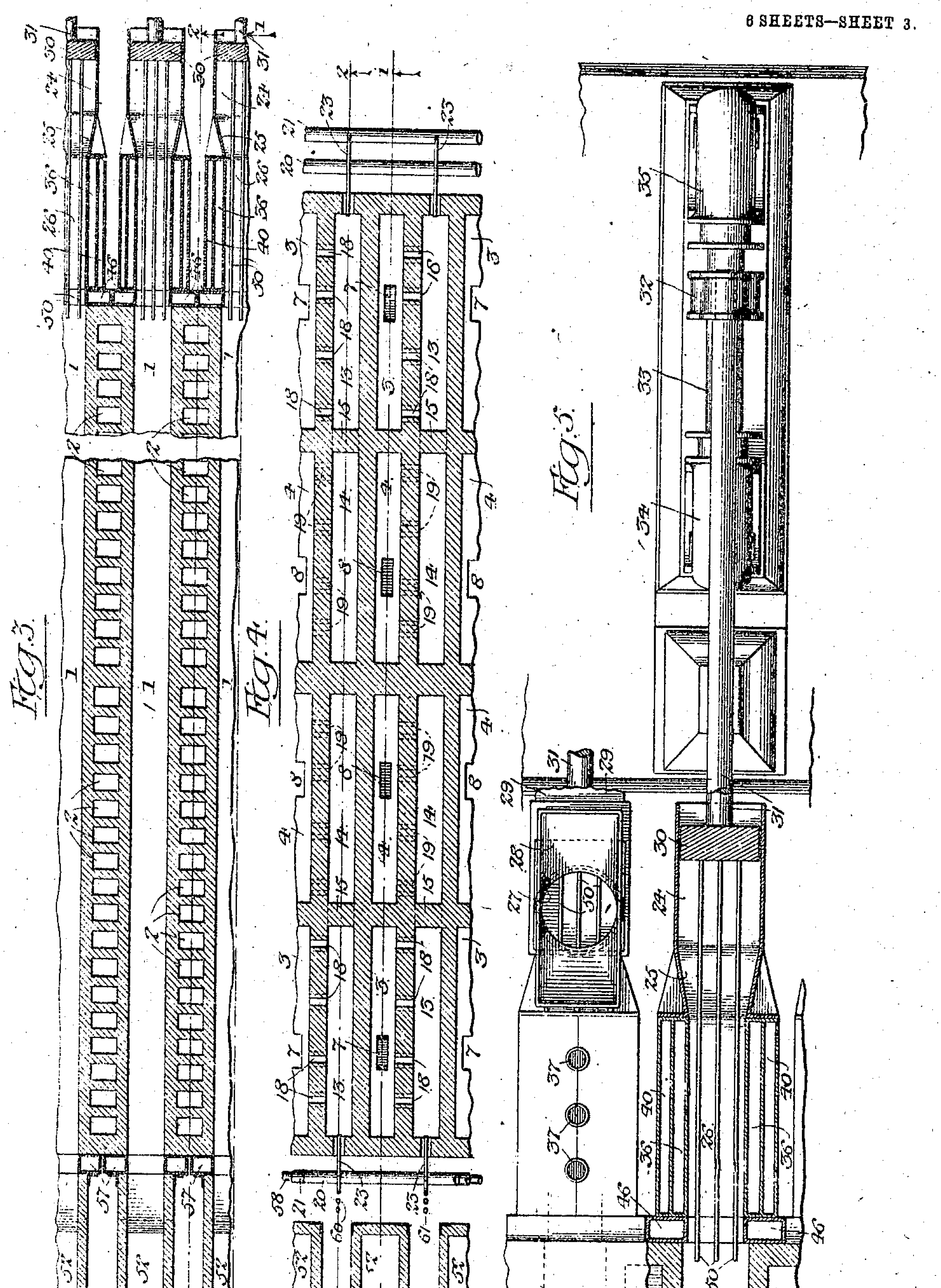

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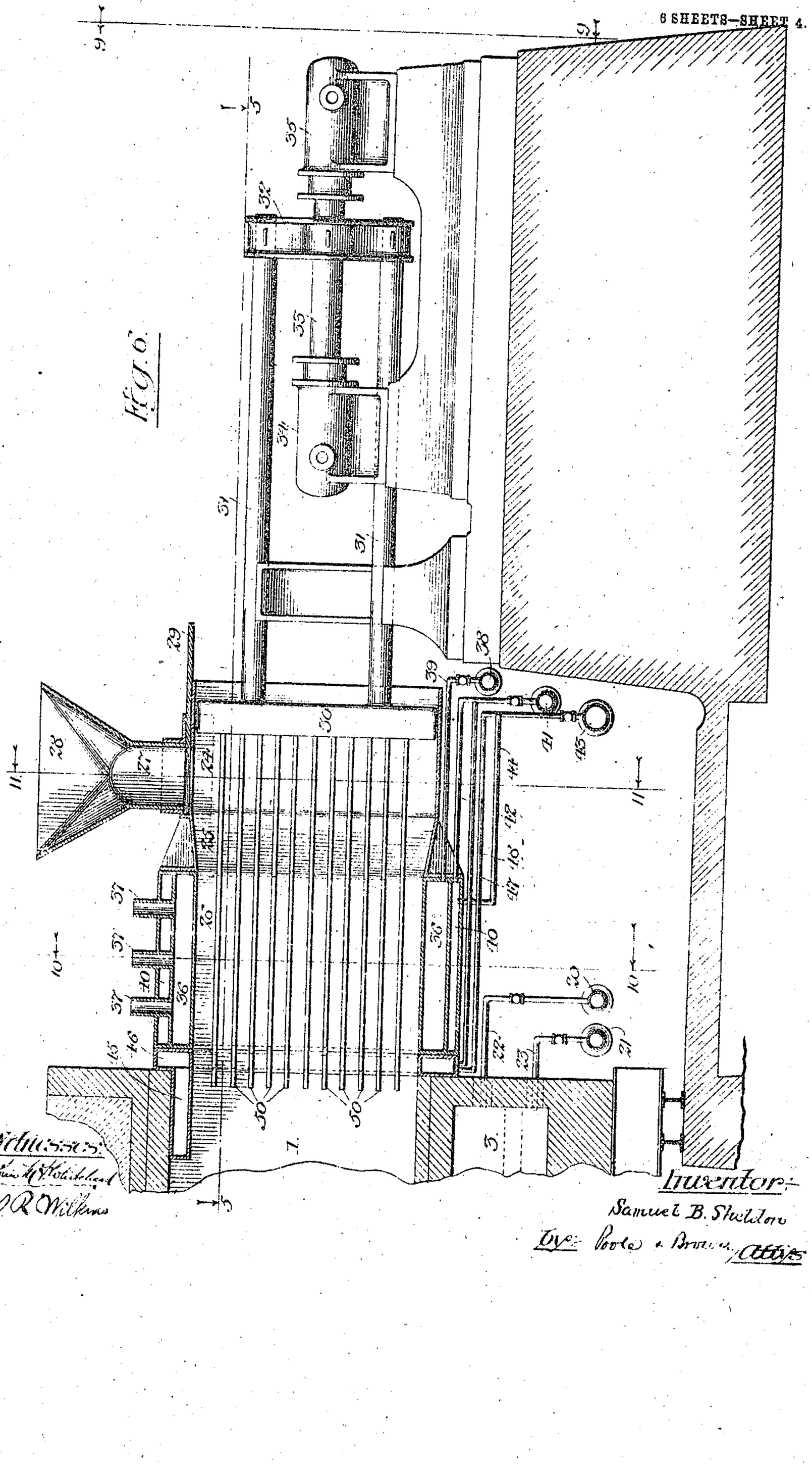
6 SHEETS—SHEET 4.

FIG. 6.



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6 SHEETS—SHEET 5.

Fig. 9.

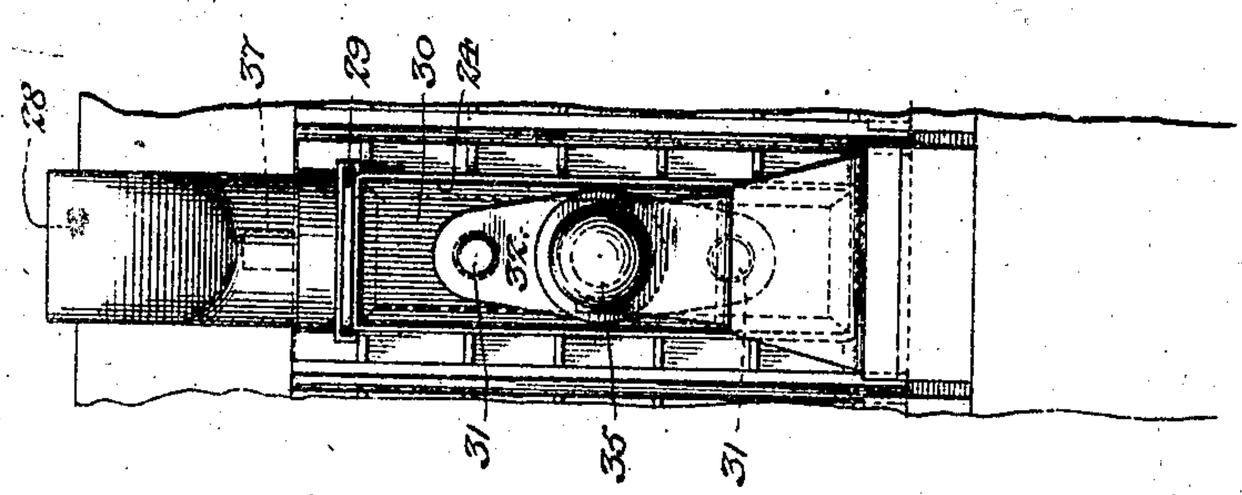


Fig. 8.

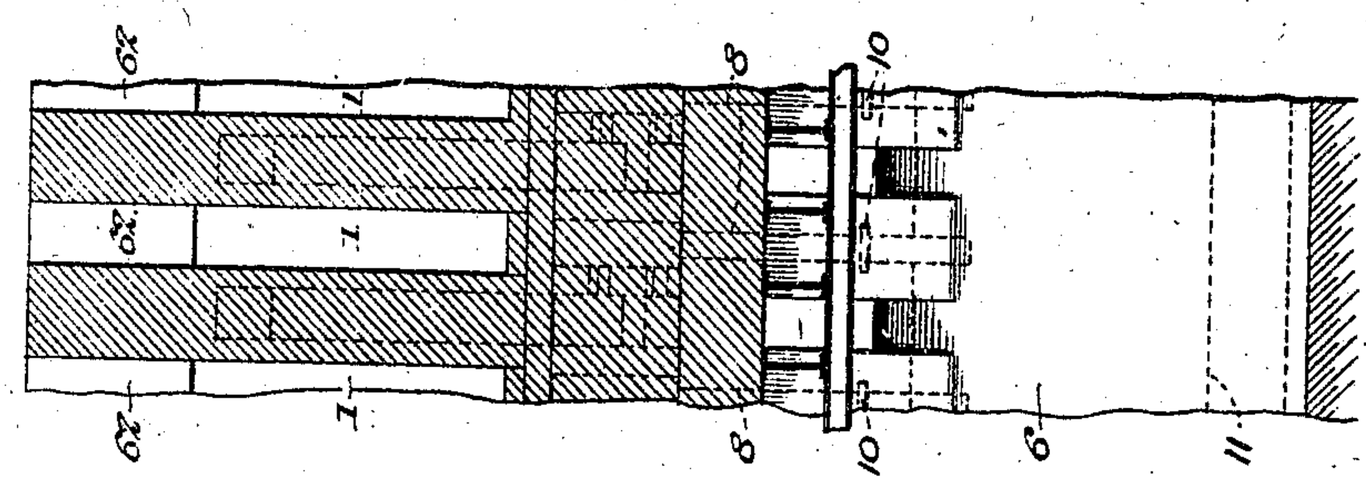
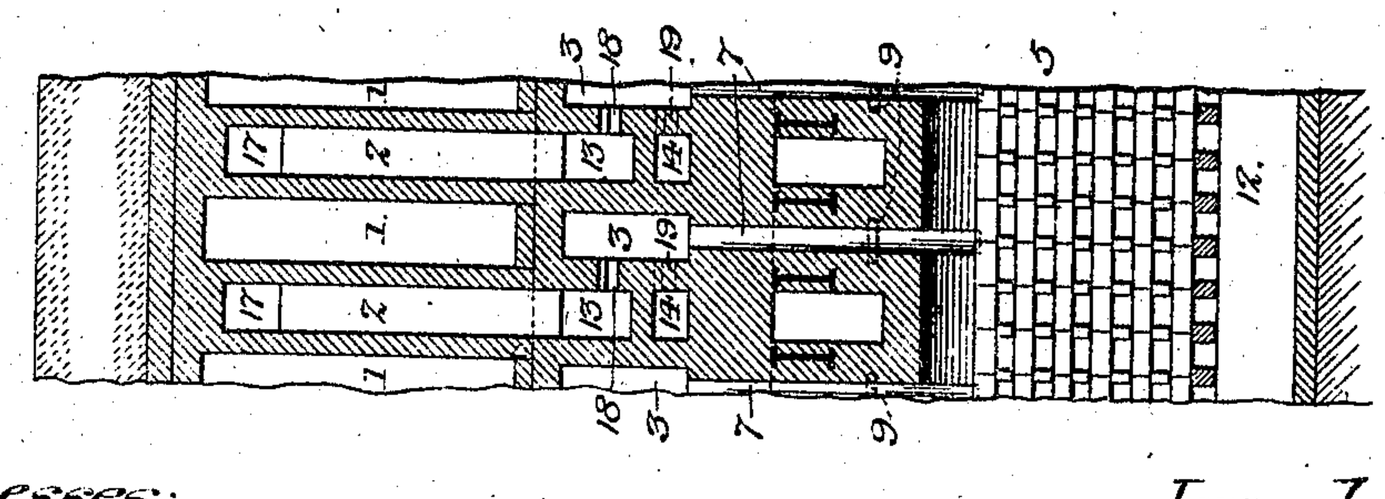


Fig. 7.



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6 SHEETS—SHEET 6

FIG. 12.

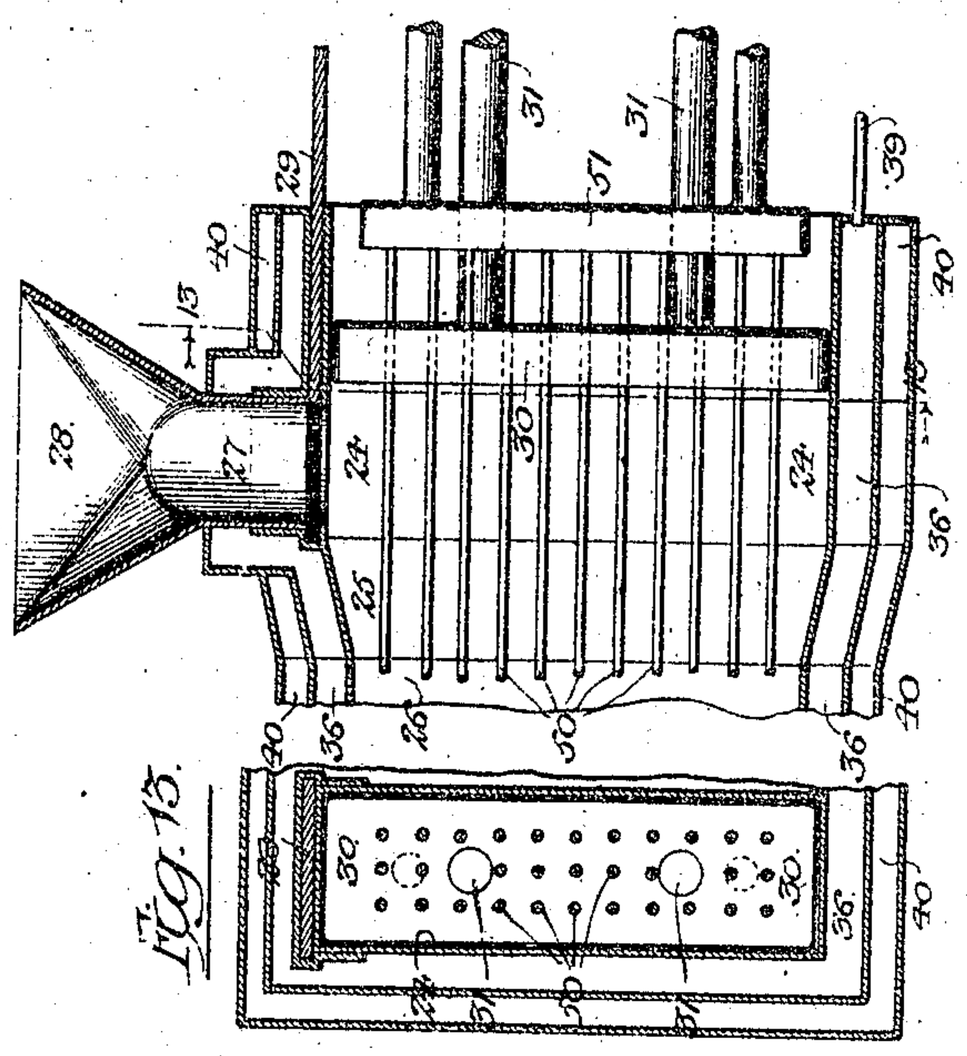


FIG. 13.

FIG. 11.

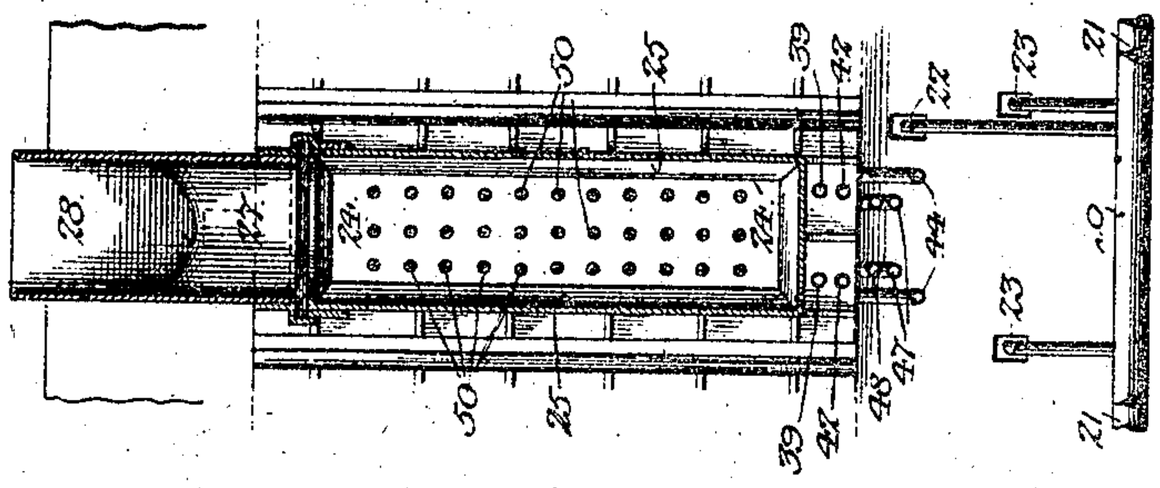
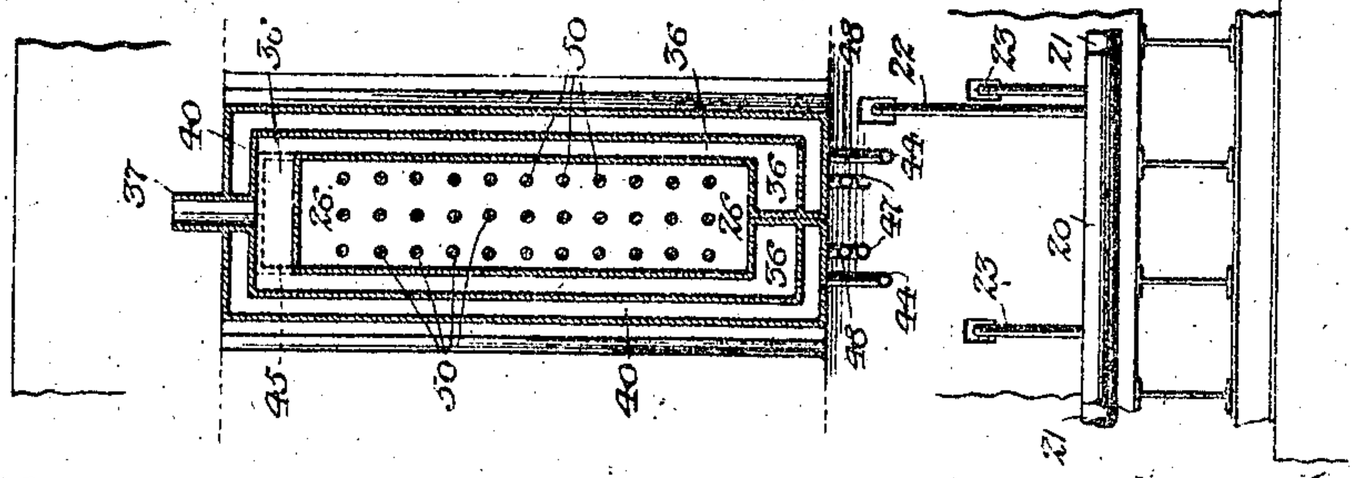


FIG. 10.



Witnesses:
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UNITED STATES PATENT OFFICE.

SAMUEL BERTRAM SHELDON, OF BUFFALO, NEW YORK.

COKE-FURNACE.

No. 847,614. Specification of Letters Patent. Patented March 19, 1907.

Application filed April 21, 1906. Serial No. 313,072.

To all whom it may concern:

Be it known that I, SAMUEL BERTRAM SHELDON, a citizen of the United States, of Buffalo, in the county of Erie and State of New York, have invented certain new and useful Improvements in Coke-Furnaces; and I do hereby declare that the following is a full, clear, and exact description thereof, reference being had to the accompanying drawings, and to the letters of reference marked thereon, which form a part of this specification.

This invention relates to improvements in the art of coking or distilling coal for the manufacture of coke and the production of gas, and more especially to a novel apparatus effecting the coking or distillation of coal and at the same time saving the gases produced in the operation in order that the same may be utilized for heating or other purposes and valuable by-products produced in the distilling or coking operation recovered.

An apparatus is illustrated in the accompanying drawings. Said apparatus embraces general features of construction as follows: For effecting the coking or distillation of the coal a coking-oven is employed of the kind generally known as a "by-product" oven, or one in which the coal during the coking operation is contained within a closed chamber and is subjected to the action of heat transmitted thereto through the walls of said chamber. I have shown in the drawings and prefer to use the type of oven commonly known as the "Otto Hoffmann" oven, in which the coking-chamber is arranged horizontally or is horizontally elongated and is adapted for the introduction of coal at one end thereof and the discharge of the coke from the opposite end thereof, the coal during the coking operation being advanced along or through the oven and said oven being closed against access of outside air and provided with delivery ducts or passages through which pass the gases produced during the coking operation. The oven illustrated, moreover, consists of two parts or sections arranged end to end to form a continuous coking-chamber, said sections being provided with separate or independently-controllable heating means, so that the part or section of the oven into which the coal is first introduced may be maintained at a higher temperature than the section adjacent to the discharge end of the oven for a purpose hereinafter stated. In connection with said oven at the receiving end thereof are located means for forcing the coal into and through the oven, means for compressing the coal preparatory to its introduction into the oven, and means for preheating the coal after it is compressed and before it enters the oven. The coal feeding, compressing, and preheating means embraces generally a receiving-chamber, a preheating-chamber, and a tapered passage connecting said receiving and preheating chambers and which is larger at its receiving than at its delivery end. The said receiving-chamber, the tapered passage, and preheating-chamber are connected with each other so as to constitute a continuous passage, which at the delivery end of the preheating-chamber opens into the receiving end of the oven. The receiving-chamber is provided at its top with an opening through which the coal, preferably in pulverized form, may be introduced into said chamber, and in said receiving-chamber is located a horizontally-reciprocating plunger operating in its advance movements to force the charges of coal introduced into the chamber at the front of said plunger through said tapered passage and the preheating-chamber into the coking-chamber. The tapered sides of the said passage constitute in connection with said plunger the means for compressing the coal, the inclined or tapered sides of said passage serving to effect compression of the coal laterally or from the outside toward the center of the mass of coal as the latter is forced through said passage by the action of the plunger. The walls of the preheating-chamber are preferably made of relatively thin metal and are surrounded by a combustion-chamber, in which is burned gaseous or other fuel, the heat produced being transmitted through the said metal walls to the mass of coal within the chamber. The compacted mass of coal which enters the preheating-chamber from the said tapered passage in which it is compressed is subjected in its passage through the preheating-chamber to any desired degree of heat. Within said passage formed by the receiving-chamber, the tapered passage, and the preheating-chamber are located a series of metal rods, arranged parallel with the path of the coal and projecting from the inner face of said plunger. Said rods serve to form continuous perforations or channels extending longitudinally through the compressed mass of coal as said mass is advanced toward and

into the oven, the coal being compressed between or around the said rods in the advance movements of the plunger and the rods extending such distance toward or into the oven that the longitudinal passages or perforations formed by the action of said rods will not be closed by lateral pressure on the mass after the latter passes the free or advance ends of the rods. The passages or perforations so formed in the mass of coal by the rods referred to serve to facilitate the escape of gases and volatile matters from the coal, and to thereby aid in the coking operation, while giving more uniform results in the coking of the mass, and especially the central part thereof. At the discharge or delivery end of the coking-chamber means are provided for permitting the discharge of coke without the admission of air, the same preferably consisting of a depending delivery pipe or passage provided with two valves, only one of which is opened at a time during the discharge of the coke.

The operation of the apparatus described is practically continuous, and the coking or distilling operation takes place without the admission of external air to the oven. The entrance of air to the receiving end of the oven is prevented by the solid mass of compressed coal, which fills the tapered compressing-passage and the preheating-chamber, and access of air into the delivery end of the oven is prevented by the double valves in the discharge-duct, as hereinbefore described. The compressed and preheated mass of coal is advanced from the preheating-chamber into the oven by an intermittent or step-by-step movement produced by the reciprocation of the feeding and compressing-plunger, and such mass is advanced along or through the oven as the coking operation takes place, the gases generated being withdrawn continuously from the coking-chamber. When the coking-chamber is made in parts or sections, as above described, it is intended that the coking operation shall take place mainly in the section in which the coal is received or that adjacent to the receiving end of the oven, and the section adjacent to the delivery end of the oven is maintained at a lower temperature, so that a partial cooling of the mass of coke will take place before the discharge of the same from the oven.

My invention may be more readily understood by reference to the accompanying drawings, in which—

Figure 1 is a view of an apparatus embodying my invention in longitudinal vertical section taken on a plane passing through the center of the coking-chamber of the oven on the line 1 1 of Fig. 3. Fig. 2 is a like section taken on a plane passing through the heating-flues of the oven on the line 2 2 of Fig. 3. Fig. 3 is a horizontal section taken on the line 3 3 of Figs. 1 and 2. Fig. 4 is a horizontal section taken upon line 4 4 of Figs. 1 and 2. Fig. 5 is a plan view of the parts located at the receiving ends of two of the ovens shown in Figs. 3 and 4, the parts for feeding, compressing, and preheating the coal employed in connection with one of the ovens being shown in horizontal section taken on the line 5 5 of Fig. 6. Fig. 6 is a view of the parts at the receiving end of one of the ovens, showing said parts partially in side elevation and partially in central vertical section on the line 1 1 of Fig. 3. Fig. 7 is a cross-section taken on line 7 7 of Figs. 1 and 2. Fig. 8 is a cross-section taken on line 8 8 of Figs. 1 and 2. Fig. 9 is an end view of the parts associated with one of the ovens, taken upon line 9 9 of Fig. 6. Fig. 10 is a cross-section taken upon line 10 10 of Fig. 6. Fig. 11 is a cross-section taken upon line 11 11 of Fig. 6. Fig. 12 is a detail sectional view of the compressing and preheating device, showing a modified form thereof. Fig. 13 is a cross-section taken upon line 13 13 of Fig. 12.

The coking-oven illustrated in the accompanying drawings is provided with a series of coking-chambers 1 1 1, which are arranged side by side, as common in the construction of Otto Hoffmann ovens. Each of the said coking-chambers is equipped with coal feeding, compressing, and preheating devices at the receiving end thereof and with a delivery device at its exit or discharge end, the drawings illustrating in full only one of said coking-chambers and its associated parts. In the walls of the oven which separate the coking-chambers from each other are formed vertical flues or heating-passages 2 2 2. The coking-chambers 1 1 1 are continuous and of uniform internal dimensions from their receiving to their discharge ends; but the oven as a whole, consists, in effect, of two sections arranged end to end and each of which is provided with complete heating means separate from the heating means of the other section, so that the temperature maintained in the two sections may be independently or separately controlled. Each section of the oven therefore corresponds with a complete Otto Hoffmann oven or, in other words, the two sections together constitute two complete Otto Hoffmann ovens placed end to end with their coking-chambers joined to form, in effect, one continuous coking-chamber.

The means for heating the two sections of each coking-chamber being alike the parts or passages constituting the heating means for the two sections are lettered alike in the drawings, and the same description of said heating means will apply to both of said sections.

Beneath each coking-chamber 1 are located two longitudinally-arranged passages 3 and 4, separated from each other by a vertical transverse partition. Connected with said chambers 3 and 4 are two regenerators

5 and 6 by means of passages 7 and 8, provided with gates or valves 9 and 10. Said regenerators 5 and 6 are located below and extend transversely of the coking-chambers and contain the usual checker-work. Connected with the lower parts of the regenerators are passages or flues 11 11 and 12 12, which are adapted to be connected either with a stack or chimney or with an air-inlet passage, as common in coking-ovens having two regenerators as heretofore constructed.

Between the longitudinal chambers or passages 3 and 4, associated with two adjacent coking-chambers, are located two longitudinal passages 13 and 14, which communicate with the lower ends of the vertical flues or passages 2 2 in the walls separating said chambers. Said passages 13 and 14 are separated from each other by a vertical partition-wall 15 and by a horizontal partition 16, extending from the bottom of said wall 15 to the external end wall of the oven, so that the lower part of said chamber 14 extends the full length of one section of said oven. The chamber 3 is connected with the chamber 13 by holes or apertures 18 18, formed in the longitudinal wall between said chambers, and the chamber 4 is connected with the chamber 14 by like holes or apertures 19 19. Said chambers 13 and 14 constitute combustion-chambers in which gaseous fuel is burned, air for supporting combustion being supplied from the chambers 3 or 4 through the passages 18 or 19. As shown in the drawings, 20 and 21 indicate gas-supply mains provided with branch pipes 22 and 23, which deliver gas to the outer ends of the chambers or passages 13 and 14 through the end wall of the oven structure.

The operation of the regenerators and associated passages corresponds with that of an Otto Hoffmann oven and is as follows: Assuming the regenerator 5 to be connected with the air-inlet duct and the regenerator 6 with a stack or chimney-flue, air entering the flues 11 11 of said regenerator 5 passes upwardly through the checker-work therein, which has been previously heated, and such air in a heated condition passes through the passage 7 to the chamber 3, from which through the openings 18 18 it enters the chamber 13. Fuel-gas delivered to said chamber 13 from the pipe 23 is burned therein, and the products of combustion rise through the vertical passages 2 2 above the chamber 13 and passing horizontally along the passage 17 descend through the flues 2 2 2 above the chamber 14, from whence they pass through the openings 19 19 to the chamber 4, and thence through the passage 8 to the regenerator 6 and out through the flues 12 12 into the stack. After the checker-work in the regenerator 5 has become cooled and that in the regenerator 6 heated by the passage therethrough of the outgoing products of combustion the regenerator 5 is connected with the stack and the regenerator 6 with the air-supply duct, combustion then taking place in the chamber 14, and the products of combustion pass from said chamber through the flues 2 2 into the chamber 13, and thence out through the chamber 3 and the regenerator 5 to the stack.

The heating devices for the opposite end portions or sections of the oven being alike and being provided with the usual heat-controlling means, as the valves in the gas-supply pipes 22 and 23, a higher temperature may be maintained in the part or section adjacent to the inlet or receiving end of the coking-chamber than in the part or section adjacent to the outlet or delivery end of said chamber. The provision of means for separately controlling the temperature in the two parts or sections of the coking-chamber is of great importance for the reason that the best results in coking are obtained by first subjecting the coal to temperatures sufficiently high to effectually complete the coking operation and to thereafter subject the mass of coke to a lower temperature for a considerable period, so as to afford considerable cooling thereof before its discharge from the oven.

Now referring to the coal feeding, compressing, and preheating devices at the receiving end of the oven, these parts, as shown in the drawings, are made of metal and embrace features of construction as follows: 24 indicates a coal-receiving chamber, 25 a tapered coal-compressing passage, and 26 a preheating-chamber. Said receiving-chamber, the tapered compressing-passage, and the preheating-chamber are connected with each other to form a continuous passage through which the coal is advanced from the receiving-chamber to the oven, the bottom wall of the preheating-chamber being level with the bottom of the coking-chamber, while its side walls are parallel with each other and located at a distance apart somewhat less than the distance between the side walls of the coking-chamber, so as to give clearance-spaces at the sides of the mass of coal advanced from the preheating-chamber into the oven. The top wall of the preheating-chamber is located somewhat below the level of the top wall of the oven, so as to leave clearance-space at the top of the oven. At the top of the receiving-chamber 24 is located an inlet or feed passage 27, provided with a hopper 28 and with a horizontal sliding valve or gate 29, which latter is located adjacent to the top wall of the receiving-chamber. The side and bottom walls of said receiving-chamber are parallel with each other, and in the said receiving-chamber is located a horizontally-reciprocating plunger 30, which fits and slides in contact with the side, top, and bottom walls of said chamber. Power-actuated means for giving reciproca-

tory motion to the plunger 30 may be of any desired form or construction. The devices for this purpose shown in the drawings consist of two horizontal rods 31, which are attached to an upright cross-head 32, secured to the center of a double-ended piston or plunger 33, the opposite ends of which slide in oppositely-arranged hydraulic cylinders 34 and 35, to which fluid under pressure is admitted for advancing and retracting the plunger 30. The side, top, and bottom walls of the tapered passage 25 join the corresponding walls of the receiving-chamber 24 and the preheating-chamber 26, and the inclination of said walls of the tapered passage is such as to give a desired degree of compression to the mass of coal forced therethrough from the receiving-chamber by the action of the plunger 30. Such mass of coal in the advance movement of the plunger 30 is forced by said plunger from the receiving-chamber through said passage 25 into the preheating-chamber 26, the oblique side, top, and bottom walls of said passage serving to compress the mass laterally in all directions or from the exterior thereof toward the center of the same. The side, top, and bottom walls of the preheating-chamber 26 are parallel with each other and are formed by a metal shell, which is preferably made in two parts divided on a vertical longitudinal plane. Surrounding the preheating-chamber is a combustion space or chamber 36, in which is burned a mixture of gas and air for heating the coal in its passage through said preheating-chamber. Said combustion-chamber 36 is provided at its top with exit tubes or pipes 37 37 37 for the exit of products of combustion. Fuel-gas is supplied to the bottom of said chamber 36 by means of a fuel-supply main 38, provided with supply-pipes 39 39, leading into the bottom of said chamber. The walls of the preheating and combustion chambers preferably consist of two hollow shells or sections joined to each other along the longitudinal centers of the said chambers. The said combustion-chamber 36 is shown as water-jacketed, the same being surrounded by an exterior shell forming a water-chamber 40. Water is supplied to said chamber by means of a water-supply main 41, connected with the chamber by means of branch pipes 42 42, a waste-pipe 43, connected with the water-jacket 40 by branch pipes 44, serving to carry away the water after it is circulated through said water-jacket.

45 indicates a hollow metal water-cooled apron which is arranged horizontally beneath the top wall of the oven, at the receiving end thereof, and the bottom wall of which forms a horizontal extension or continuation of the top wall of the preheating-chamber. Said apron 45 extends for some distance into the oven and serves to prevent the top of the compressed mass of coal from rising into contact with the top wall of the oven under the pressure applied through the plunger 30 to the mass of coal for forcing it through the preheating-chamber and into and through the oven. Said water-cooled apron 45 has the form of a hollow metal box, and the same is preferably made to form a part or continuation of a hollow metal water-cooled ring 46, applied between the combustion-chamber 36 and the adjacent end of the masonry structure of the oven.

47 and 48 indicate water supply and return pipes for the water-cooled ring 46, said pipes being connected with the supply and return pipes 42 and 44, hereinbefore referred to.

Extending from the inner face of the plunger 30 are a plurality of rods 50 50, arranged parallel with each other and parallel with the sides of the receiving and preheating chambers. In the form of construction illustrated in Figs. 1 to 11 the rods 50 50 are attached to and move with said plunger 30 and extend from the face of said plunger forwardly through the receiving-chamber 24, the tapered passage 25, and the preheating-chamber 26. Said rods are preferably made long enough to extend some distance into the coking-oven when the plunger is advanced. The coal, which is introduced in pulverized form into the receiving-chamber in advance of the plunger, surrounds said rods, and in the advance movement of the plunger the coal is packed solidly around the rods, so that said rods form in the mass of coal a plurality of longitudinal passages, openings, or perforations. As the mass of coal is forced through the tapered passage 25 it is compressed or solidified, and the effect of the heat to which the said mass is subjected in the preheating-chamber being to produce coherence between the particles of coal in the mass, so that it retains its solid form when it enters the coking-chamber, it follows that the longitudinal passages or perforations formed by said rods will remain in the mass after the same has been advanced beyond the free ends of said rods.

In Figs. 12 and 13 I have shown a modified construction in the perforating and preheating devices. In this instance the rods 50 50 pass through holes in the plunger 30 and are attached to a reciprocating cross-head 51. Said cross-head 51 is moved rearwardly far enough to bring the rear ends of the rods flush with the inner or working face of the plunger 30 and is retained in this position during the introduction of the supply or charge of coal to the receiving-chamber. After a charge of coal has been introduced the cross-head 51 will be advanced so as to carry the rods 50 forwardly through the fresh coal and into the longitudinal passages previously formed in the mass of coal, and the plunger and cross-head will then be advanced together. In said Figs. 12 and 13 the combus-

tion-chamber 36 is shown as extended, so as to surround the compressing-passage 25, the receiving-chamber 24, and the feed-passage 27. This construction gives increased efficiency in the preheating means, since the preheating is effected at relatively low temperature, and the longer the coal is exposed to heat before entering the coking-chamber and the larger the area of heating-surface to which it is exposed the greater will be the quantity of heat transmitted to the coal.

Now referring to the means at the exit end of the oven for discharging the coke therefrom, the same consists of a vertically-arranged discharge-pipe 52, the upper end of which is connected with the discharge end of the oven and the lower part of which extends below the floor of the oven and is provided with two vertically-separated valves 53 and 54. The valve 53 preferably consists of a horizontally-sliding gate, while the valve 54 embraces a conical closure adapted to fit against a circular seat at the bottom of the pipe 52 and is attached to an operating and supporting lever 55, which is pivoted to the pipe and has a weighted arm 56, adapted to hold the valve-closure normally in contact with its seat. The discharge-pipe 52 preferably consists of an exterior shell or casing of sheet metal provided with a lining of refractory material. A water-cooled ring 57 is preferably introduced between the pipe 52 and the adjacent end of the masonry end wall of the oven. Means illustrated for securing a circulation of water in said cooling-ring consist of supply and return mains 58 and 59, connected with the said hollow ring by pipes 60 and 61.

The two valves 53 and 54 in the discharge end of the pipe 52 are for the purpose of permitting the coke to be discharged from the furnace without admitting air thereto. As the body or mass of coke reaches the discharge end of the oven the same, being partially cooled, disintegrates and the fragments of coke fall through the ducts 52 and accumulate upon the valve 53, which is normally closed. When a considerable quantity of the coke has accumulated on the upper valve 53, the latter is withdrawn, so as to allow the accumulated coke to fall upon the lower valve 54. The valve 53 is then closed and the valve 54 opened to permit the discharge of the coke from the lower end of the pipe.

In the operation of the apparatus described, assuming that the plunger 30 has been previously advanced to force the charge of coal from the receiving-chamber into the tapered passage 25 and the preheating-chamber 26 and then withdrawn, a space will have been left between the said plunger and the rear face of the mass of coal previously forced into or compressed within the passage 25. The space in advance of the plunger is then filled by a new charge of pulverized coal, introduced through the inlet-passage 27. In the next succeeding advance movement of the plunger the charge of coal within the receiving-chamber is forced from the same into or through the tapered passage 25, while the mass of coal in said passage in advance of the newly-introduced charge is advanced through the preheating-chamber and the coking-chamber. As the mass of coal is forced through the tapered passage the walls thereof serve to compress the mass both vertically and laterally, so that the mass entering through the preheating-chamber is closely compacted and will possess the desired degree of solidity. The effect of the heat transmitted to the mass of coal through the walls of the preheating-chamber is to melt or soften the bituminous constituents of the coal or to produce partial coking of the mass, so that the particles of coal in the mass cohere and the mass will in its subsequent advance movement into and through the coking-chamber retain the form given it by being forced through the tapered compression-passage and through the preheating-chamber.

In first starting the oven in operation the oven will be filled with coal from the top through an opening 62, provided for the purpose. Heat will then be applied in the ordinary manner, and the mass of coal within the coking-chamber will be coked. In the meantime the receiving-chamber will have been filled with coal through the inlet-opening in its top, the plunger or pusher 30 being withdrawn for this purpose. The coking-chamber will then be filled with coke, and the extension of the oven formed by the preheating-chamber and the compressing-chamber filled with coal compressed therein by the action of the plunger, the coal acting as a seal which prevents the escape of gas from the receiving end of the coking-chamber, and also keeps out the atmospheric air. It will of course be understood that the gas generated in the oven passes therefrom to an exhauster, so that the coking-chamber is subject to internal pressure not greater than that of the atmosphere.

In the operation of the oven the pusher will be worked at any desired speed. For illustration, a thirty-three-foot oven produces four and two-tenths tons of coke in twenty-four hours. The movement through the oven would in this case be equivalent to about one-fourth inch per minute. During the coking operation the ordinary cooking process proceeds in the coking-chamber from the sides and bottom thereof, and the preheated coal is forced into the oven against the incandescent coke therein, so that as the preheated coal enters the coking-chamber the coking proceeds in an endwise direction, or from the incandescent portion of the mass toward the incoming uncoked portion thereof. Manifestly in the operation the

production of gas will be continuous and at a uniform rate, as will be the production of coke, while a large amount of heat will be saved, owing to the fact that the oven is never opened and emptied. By making the oven in two parts or sections equipped with separably-controllable heating means the receiving portion or end of the oven may be run at a very high heat, while the discharge end or portion thereof containing the coke may be kept at a much lower temperature, thereby effecting a partial cooling of the coke before it leaves the oven, and consequent large saving of the gas.

In a by-product oven as heretofore constructed the coking operation proceeds from the outside toward the center of the mass, the interior of the mass being quite cool during a considerable extent of the operation, so that tar and pitch tend to condense in the center of the mass. The center being the last portion coked in case of an oven of the usual cross-sectional form and dimensions—that is to say, from about fifteen inches to twenty-two inches wide and about five feet in height—a vertical cleavage-line is produced. On either side of this cleavage-line the coke resulting from the final distillation of the tar or pitch, which has been deposited in this vicinity on account of the low temperature of the center of the mass, will be very porous. By the preheating of the coal before it is introduced into the oven the tendency to condensation of the tar and pitch in the center of the mass will be greatly lessened, so that the preheating tends to produce equality in the character of the coke throughout the mass. The use of perforating means such as described to form longitudinal holes or passages in the body of the coke will also tend to prevent such condensation of tar and pitch in the center of the mass and give uniformity to the product, while at the same time making more rapid the operation of coking because facilitating the escape of gases and volatile constituents of the coal from the interior of the mass during the coking operation.

An important feature of my invention is the provision of means for preheating the coal as it is advanced in a compact and continuous mass to and into the coking retort or oven. With respect to this feature my apparatus differs from one having an upright or vertically-elongated coking-chamber to the top of which the coal is fed and from the bottom of which the coke is removed, for the reasons that in the operation of such a vertical oven, in which the downward movement of the mass of coal through the oven is effected by the action of gravity and the coke is removed from the bottom of the retort substantially as fast as it is fed to the top thereof, there can be substantially no compression of the coal prior to the first heating thereof, because if there be substantial compression of the mass due to the weight of the coal such compression does not take place in the upper part of the retort, but necessarily occurs only in the lower part of the retort, and is due to the weight of the coal in the upper part of the retort and to the checking of the descent of the coal through the lower part of the retort by reason of its friction against the sides thereof.

In the operation of the apparatus illustrated the gravity of the coal is not a factor in the advance and compression thereof, because the mass of coal is moved horizontally toward the oven or retort by pressure on the outer end of the mass, the result being that the coal in the mass is held in a compressed state at the time heat for preheating is applied thereto and the coal is prepared for the coking process by being both compressed and preheated to produce adherence of the particles into a solid mass, which is advanced unbroken into the oven.

While the endwise pressure applied to the outer end of the mass of coal as it is advanced into the oven, together with the resistance to the forward movement of the mass, due to its frictional contact with the walls of the passage surrounding it, will in some cases or with some kinds of coal produce sufficient compression of the mass, yet the employment of means for effecting lateral compression by which the mass is compressed from its outside toward its center is of great practical importance, because insuring the bringing about of such amount of compression as to certainly result in the adherence to each other of the particles of coal in the mass when subjected to the heat employed for heating.

The devices for effecting perforation of the mass when the coal is in its compressed condition and subjected to heat for preheating are also of great importance, because the formation of channels or perforations in the mass when the same is under compression and when the particles of the mass have been caused to adhere to each other by the heat due to preheating results in the perforations remaining in the mass after the same reaches the oven and is therein subjected to coking heat and the consequent production of coke of substantially uniform quality throughout the mass.

The direction of movement of the mass of coal in its approach toward the coking oven or retort is herein described as "horizontal" in order to distinguish applicant's apparatus from those having a vertically-elongated or upright retort and in which the movement of the coal into and through the retort is effected by the weight or gravity of the coal; but it is to be understood that by the use of such term I do not desire to be limited to one form of apparatus in which the path of movement of the coal is strictly horizontal, but

intend to include one in which the direction of movement of the mass of coal is so nearly horizontal that its advance toward and into the coking retort or oven is not effected by gravity, but is produced substantially or mainly by pressure applied to the mass in a manner to both compress the mass endwise and to give the desired advance movement to the same.

I claim as my invention—

1. The combination with a coking-chamber, of means for introducing coal into the coking-chamber in the form of a solid and continuous mass, embracing a passage having closed connection with the receiving end of said coking-chamber, means for applying pressure horizontally to the outer end of coal in said passage to compress the same into a compact mass and advance the mass from the passage into said coking-chamber and means for preheating the mass of coal while under compression and during its advance toward the coking-chamber to give solid and continuous character to the mass prior to its entrance into said coking-chamber.

2. The combination with a coking-chamber, of means for applying both endwise and lateral pressure to a mass of coal for the purpose of compressing the same and forcing it into said chamber, and means for preheating the mass during its movement toward said chamber.

3. The combination with a coking-chamber, of a preheating-chamber having closed connection with the receiving end of said coking-chamber, means for heating the walls of the preheating-chamber, and means for applying pressure horizontally to the outer end of a mass of coal to compress the same and force it into said preheating-chamber and from the same into the coking-chamber.

4. The combination with a coking-chamber, of a preheating-chamber, a receiving-chamber, and means for applying endwise pressure to the outer end of a mass of coal in said receiving-chamber to compress the same and force it from the receiving-chamber through the preheating-chamber into the coking-chamber.

5. The combination with a coking-chamber, of a preheating-chamber, a receiving-chamber, means for applying endwise pressure horizontally to the outer end of a mass of coal in the receiving-chamber and preheating-chamber to compress the same and force it from the receiving-chamber through the preheating-chamber into the coking-chamber, embracing a reciprocating plunger sliding in the said receiving-chamber.

6. The combination with a coking-chamber, of a preheating-chamber, means for applying horizontal endwise pressure to the outer end of a mass of coal within the preheating-chamber, for compressing said coal and forcing the same through the preheating-chamber into the coking-chamber, and an outlet-passage for the coke at the discharge end of the coking-chamber provided with means adapted for the discharge of the coke without the admission of air to the coking-chamber.

7. The combination with a horizontal coking-chamber, of a preheating-chamber, means for applying pressure horizontally to the outer end of a mass of coal in said preheating-chamber to compress the coal and force the same through the preheating-chamber into the coking-chamber, and an outlet-passage for coke at the discharge end of the coking-chamber provided with two separated valves.

8. The combination with a horizontal coking-chamber, of a preheating-chamber, a receiving-chamber, means for applying horizontal, endwise pressure to the outer end of a mass of coal held in the preheating-chamber and receiving-chamber for compressing coal and forcing it from said receiving-chamber to said preheating-chamber into the coking-chamber, and an outlet-passage at the discharge end of the coking-chamber provided with means adapted for the discharge of the coke without the admission of air to the coking-chamber.

9. The combination with a coking-chamber, of means for compressing coal and introducing it into said coking-chamber, embracing a tapered passage which is larger at its inlet than at its discharge end and the discharge end of which has closed connection with the coking-chamber, and means for applying endwise pressure to coal introduced into the outer end of said tapered passage acting to force the coal in a continuous mass through said tapered passage and from the same into the coking-chamber.

10. The combination with a coking-chamber, of means for applying lateral pressure to a mass of coal and introducing it into the coking-chamber, embracing a tapered passage which is larger at its inlet than at its discharge end, and the discharge end of which has closed connection with the coking-chamber, and a reciprocating plunger acting intermittingly on coal introduced into the inlet end of said passage and acting to force said coal in a continuous mass through said tapered passage and from said passage into the coking-chamber.

11. The combination with a coking-chamber, of a receiving-chamber, a tapered passage between the receiving-chamber and coking-chamber, having closed connection with the latter, said passage being larger at its inlet than at its discharge end, and means for applying intermittent, endwise pressure to coal introduced into said receiving-chamber, acting to force the coal in a continuous mass through said tapered passage and from the same into the said coking-chamber.

12. The combination with a coking-chamber, of a receiving-chamber, a tapered passage between said receiving-chamber and coking-chamber, having closed connection with the latter, said passage being larger at its inlet than at its discharge end, and a reciprocating plunger in the receiving-chamber acting upon coal introduced into said receiving-chamber to force the said coal in a continuous mass through said tapered passage and from the same into the coking-chamber.

13. The combination with a coking-chamber, of a receiving-chamber having an inlet for coal at its top, a tapered passage between the said receiving-chamber and the coking-chamber, having closed connection with the latter, said passage being smaller at its inlet than at its discharge end and a reciprocating plunger in the receiving-chamber acting on coal introduced into said receiving-chamber to force said coal in a continuous mass through said tapered passage and from the same into the coking-chamber.

14. The combination with a coking-chamber, of a preheating-chamber, and means for compressing and feeding coal to the preheating-chamber embracing a tapered passage smaller at its discharge than at its inlet end, and means for forcing the coal through said tapered passage into the preheating-chamber.

15. The combination with a coking-chamber, of a preheating-chamber, a receiving-chamber, a tapered passage between the receiving-chamber and the preheating-chamber, said passage being smaller at its outlet than at its inlet end, and means for forcing coal from the receiving-chamber through said tapered passage into the preheating-chamber.

16. The combination with a coking-chamber, of a preheating-chamber, a receiving-chamber, a tapered passage between the receiving-chamber and the preheating-chamber, said passage being smaller at its outlet than at its inlet end, and means for forcing coal from the receiving-chamber through said tapered passage into the preheating-chamber embracing a plunger in said receiving-chamber.

17. The combination with a coking-chamber, of a preheating-chamber, a receiving-chamber having an inlet for coal at its top, a tapered passage between the receiving-chamber and the preheating-chamber, said passage being smaller at its outlet than at its inlet end, and a reciprocating plunger in the receiving-chamber.

18. The combination with a coking-chamber, of a passage having closed connection with the receiving end of said coking-chamber, means for applying endwise pressure to the outer end of a mass of coal in said passage for the purpose of compressing the same and forcing it through said passage into said coking-chamber without admitting air to the latter, means for perforating the mass of coal during its movement through said passage toward said coking-chamber, and an outlet-passage for the coke at the discharge end of said coking-chamber provided with means adapted for effecting the discharge of the coke without admitting air to said coking-chamber.

19. The combination with a coking-chamber, of means for applying both endwise and lateral pressure to a mass of coal for the purpose of compressing the same and forcing it into said chamber, and means for forming perforations in the compressed mass during its movement toward said chamber.

20. The combination with a coking-chamber, of a preheating-chamber having closed connection with the receiving end of said coking-chamber, means for compressing coal preparatory to its introduction into the preheating-chamber and for forcing the compressed coal through the preheating-chamber into the coking-chamber, and means for forming perforations in the compressed coal.

21. The combination with a coking-chamber, of a passage having closed connection with the receiving end of said coking-chamber and means for compressing, perforating and preheating coal and forcing it through said passage into the coking-chamber.

22. The combination with a coking-chamber, of means for compressing, preheating and perforating coal preparatory to its introduction into said coking-chamber, said means comprising a passage in which the coal is compressed, perforated and preheated and which is directly connected with the receiving end of the coking-chamber, and means for forcing the coal through said passage into the coking-chamber.

23. The combination with a coking-chamber, of means for laterally compressing and for preheating coal preparatory to its introduction into the coking-chamber comprising a continuous passage in which the coal is compressed and preheated, which passage is directly connected with the receiving end of the coking-chamber, means for applying pressure to the outer end of a mass of coal in said passage to force the coal through said passage into the chamber, means for heating the walls of said passage, and means at the outer end of the coking-chamber for discharging the coke therefrom, without admitting air to the chamber.

24. In combination with a coking-chamber, means for compressing, perforating, and preheating coal preparatory to its introduction into said coking-chamber, comprising a continuous passage in which the coal is compressed, perforated and preheated, which passage is directly connected with the receiving end of the coking-chamber, means for forcing the coal through said passage into the

said coking-chamber, and means at the outlet end of the coking-chamber for discharging the coke therefrom without the admission of air to said coking-chamber.

25. The combination with a coking-chamber, of a preheating-chamber having closed connection with the receiving end of said coking-chamber, means for compressing coal preparatory to its introduction into the preheating-chamber, means for forming perforations in the compressed coal and means for forcing the compressed and perforated coal through the preheating-chamber into the coking-chamber.

26. The combination with a coking-chamber, of a preheating-chamber, a receiving-chamber, a passage between the receiving-chamber and the preheating-chamber smaller at its outlet that at its inlet end, means for forcing coal from the receiving-chamber through the preheating-chamber into the coking-chamber, and means for forming longitudinal perforations in the compressed coal preparatory to its entrance into the coking-chamber.

27. The combination with a coking-chamber, of means for applying endwise pressure to the outer end of a mass of coal to compress the same and force it into the coking-chamber, and means for forming perforations in the compressed mass embracing a plurality of rods located in the space in which the coal is compressed, parallel with the path of movement of the coal in its movement toward the coking-chamber.

28. The combination with a coking-chamber, of a preheating-chamber, means for compressing coal preparatory to its introduction into the preheating-chamber, means for forcing the compressed coal through the preheating-chamber into the coking-chamber, and means for forming perforations in the compressed coal embracing a plurality of rods located within the space in which the coal is compressed and within the preheating-chamber, said rods being arranged parallel with the direction of movement of the coal in its passage through the preheating-chamber into the coking-chamber.

29. The combination with a coking-chamber, of a receiving-chamber, a preheating-chamber, a tapered passage between the receiving-chamber and the preheating-chamber, said passage being smaller at its outlet than at its inlet end, means for forcing the coal from the receiving-chamber through said tapered passage into the preheating-chamber, and means for forming perforations in the compressed coal comprising a plurality of rods extending through said tapered passage and into the preheating-chamber, said rods being parallel with the path of the coal in its movement through said tapered passage and the preheating-chamber.

30. The combination with a coking-chamber, of a receiving-chamber, a preheating-chamber, a tapered passage between the receiving-chamber and the preheating-chamber, said passage being smaller at its outlet than at its inlet end, a reciprocating plunger in the receiving-chamber, and a plurality of rods extending from the inner face of said plunger through the receiving-chamber and said passage into the preheating-chamber.

31. The combination with a coking-chamber, of a receiving-chamber, a tapered passage between the receiving-chamber and the coking-chamber, a reciprocating plunger in said receiving-chamber, and a plurality of rods extending from the inner face of the plunger through said tapered passage.

32. Means for compressing coal into a compact mass and forming perforations in said mass preparatory to the coking of the coal comprising a receiving-chamber, a tapered passage leading therefrom smaller at its outlet than at its receiving end, a reciprocating plunger in said receiving-chamber, a plurality of rods located within the receiving-chamber and said tapered passage parallel with the direction of movement of the coal, said rods passing through the said plunger, and a reciprocating head outside of said plunger to which said rods are attached.

33. Means for compressing coal into a compact mass, for preheating said mass, and for forming perforations in said mass preparatory to the coking of the coal comprising a receiving-chamber, a preheating-chamber, a tapered passage connecting the receiving-chamber with the preheating-chamber, said passage being smaller at its outlet than at its receiving end, a reciprocating plunger in said receiving-chamber, a plurality of rods extending through said tapered passage, said rods being parallel with the direction of movement of the coal, a reciprocating plunger in said receiving-chamber provided with apertures through which said rods extend, and a reciprocating head outside of said plunger to which said rods are attached.

34. The combination with a coking-chamber, of a preheating-chamber located at the inlet end of the coking-chamber, means for applying endwise pressure to the outer end of a mass of coal within said preheating-chamber to compress the coal within said chamber and force it therefrom into the coking-chamber, said preheating-chamber consisting of a metal shell, and walls surrounding said metal shell of the preheating-chamber and forming a heating-chamber.

35. The combination with a coking-chamber, of a preheating-chamber located at the receiving end of the coking-chamber, means for forcing coal through said preheating-chamber into the coking-chamber, and a hollow metal apron located below the top wall of the coking-chamber adjacent to the end of the perheating-chamber, and means

for supplying a cooling medium to said hollow apron.

36. The combination with a coking-chamber, of a preheating-chamber located at the receiving end of the coking-chamber, means for forcing coal through said preheating-chamber into the coking-chamber, and a hollow metal apron located below the top wall of the coking-chamber adjacent to the end of the preheating-chamber, a hollow metal ring interposed between the coking-chamber and the preheating-chamber, and means for supplying a cooling medium to said hollow apron and hollow metal ring.

37. The combination with a coking-chamber, of a preheating-chamber located at the inlet end of the coking-chamber, a receiving-chamber exterior to the preheating-chamber, a tapered passage larger at its inlet than at its discharge end between the receiving-chamber and the preheating-chamber; said receiving-chamber and tapered passage being formed by a metal shell, and walls surrounding said preheating-chamber, tapered passage and receiving-chamber and forming with the said metal shell a heating-chamber.

38. The combination with a coking-chamber, of a preheating-chamber, a receiving-chamber, a tapered passage larger at its receiving than its discharge end, between said receiving and preheating chambers, said preheating-chamber, receiving-chamber and tapered passage being formed by a metal shell and constituting a continuous passage, and means for applying endwise pressure to the outer end of a mass of coal in said chambers and passage for forcing the coal from the receiving-chamber through said tapered passage and the preheating-chamber into the coking-oven.

39. A coking-oven having a horizontally-arranged coking-chamber, of separately-controllable heating means for different parts or sections of said chamber, a preheating-chamber at the inlet end of said coking-chamber and means for forcing coal through said preheating-chamber into the coking-chamber.

40. A coking-oven having a horizontally-arranged coking-chamber, separately-controllable heating means for separate parts or sections of said chamber, a preheating-chamber at the receiving end of said coking-chamber, a receiving-chamber, and means for forcing the coal from the receiving-chamber through the preheating-chamber into the coking-chamber.

41. A coking-oven having a horizontally-arranged coking-chamber, separately-controllable heating means for separate parts or sections of said chamber, a preheating-chamber at the receiving end of said coking-chamber, a receiving-chamber, means for forcing the coal from the receiving-chamber through the preheating-chamber into the coking-chamber, and means at the outlet end of the coking-chamber for discharging the coke therefrom without admitting air to said coking-chamber.

42. A coking-oven having a horizontally-arranged coking-chamber, separably-controllable heating means for different parts or sections of said chamber, means at the receiving end of said coking-chamber for preheating and compressing coal and for forcing it into the coking-chamber, and means at the outlet end of the coking-chamber for discharging the coke therefrom without the admission of air to said coking-chamber.

43. A coking-oven having a horizontally-arranged coking-chamber, separably-controllable heating means for different parts or sections of said chamber, a preheating-chamber at the inlet end of said coking-chamber, means for forcing coal through said preheating-chamber into the coking-chamber, and a discharge-passage at the outlet end of the coking-chamber, said discharge-passage being downwardly directed at its exit end and being provided in its downward-directed portion with two vertically-separated valves.

44. A coking-oven having a horizontally-arranged coking-chamber, separably-controllable heating means for different parts or sections of said chamber, a preheating-chamber at the receiving end of said coking-chamber, a receiving-chamber, a reciprocating plunger in the receiving-chamber for forcing the coal from said receiving-chamber through the preheating-chamber into the coking-chamber and a discharge-passage at the outlet end of the coking-chamber, said discharge-passage being downwardly directed at its exit end and being provided in its downward-directed portion with two vertically-separated valves.

45. A coking-oven having a horizontally-arranged coking-chamber, separate heating means for separate parts or sections of said heating-chamber, embracing two separate sets of heating-passages in the walls of the oven and regenerators separately associated with said heating-passages.

46. A coking-oven having a horizontally-arranged coking-chamber, separate heating means for separate parts or sections of said chamber, embracing two separate sets of heating-passages in the walls of said oven, regenerators separately associated with said heating-passages, means at the inlet end of said coking-chamber for preheating coal and forcing the preheated coal into the coking-chamber and means at the outlet end of said coking-chamber for effecting the discharge of the coke therefrom without the admission of air to said coking-chamber.

47. The combination with a coking-chamber, of a passage having closed connection with the receiving end of said coking-chamber and means for compressing and for pre-

heating coal and for forcing the compressed and preheated coal in a continuous mass through said passage into the coking-chamber.

48. The combination with a coking-chamber, of a passage having closed connection with the receiving end of said coking-chamber, means for laterally compressing coal and means for forcing the compressed coal in a continuous mass through the said passage into the coking-chamber.

49. The combination with a horizontal coking-chamber, of means for compressing and preheating coal preparatory to its introduction into the coking-chamber comprising a continuous horizontal passage in which the coal is compressed and preheated, which passage is directly connected with the receiving end of the coking-chamber, and means for applying pressure horizontally to the outer end of a mass of coal in said passage to force the coal through said passage into the coking-chamber.

In testimony that I claim the foregoing as my invention I affix my signature, in presence of two witnesses, this 17th day of April, A. D. 1906.

SAMUEL BERTRAM SHELDON.

Witnesses:
ANTHONY H. VOGEL,
A. C. BYAM.